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The late Holocene century-scale record of climate change and tree line history in the Central Higher Himalaya, India

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The upper tree-line ecotone zone, a most prominent and contrasting floristic feature of the glaciated valleys in Central Higher Himalaya, is critically sensitive to climate change. The presentday tree line comprising of birch (*Betula utilis*), silver fir (*Abies pindrow*), and spruce (*Picea smithiana*), is situated at ca. 3500-m altitude. The century-scale vegetation and climate history inferred from the multi-proxy records (pollen, diatoms, phytoliths, total organic matter, and magnetic susceptibility) from a peat deposit (2650m a.m.s.l.) reveal that the tree-line altitude was significantly changed during the past 3500 years.

Around ca. 3500 yr BP, the upper tree line was probably located slightly above the 2650-m altitude. The significant climate shift towards drier conditions around 3300 cal yr BP, resulted in its retreat towards lower altitude. Except for a short interval of improved climate during 2300 – 2100 cal yr BP, the progressively cool and dry conditions prevailed during 3300 – ca. 1600 cal yr BP reveals that the tree line was further retreated, and reached at the lowest altitude during its 3500-year history.

An abrupt climatic shift towards significantly warm and moist conditions around 1600 cal yr BP (~400 cal AD) probably caused its ascendance above 2650-m altitude. The subsequent warm/wet and relatively stable climate during 1600 – 740 cal yr BP (Medieval Warm Period) indicates that for this period the tree-line altitude remained nearly unchanged. During decreased temperature and precipitation of the following century (740 – 640 cal yr BP), the tree line once again retreated below 2650-m altitude. In response to improved climate during ca. 640 – 460 cal yr BP period, the tree line yet again ascended to higher elevations, significantly above 2650-m altitude. With a discrete cool interval of ca. 460 - 270 cal yr BP (~1540 – 1730 cal AD, corresponding to Little Ice Age) that possibly caused a minor retreat, the consistently moist and warmer climate prevailed since 270 cal yr BP (1730 cal AD) indicates that with steady advance the tree line zone has attained its present altitude (i.e. ca. 3500 m a.m.s.l.). The multi-proxy paleoclimate record thus, indicate that with an average ascendance rate of ~1.5 m altitude/year, the upper tree line has climbed-up ca. 900-m altitude since 640 cal yr BP (~1360 cal AD).

Keywords: Late Holocene; peat deposit; pollen record; climate; tree line; Himalaya

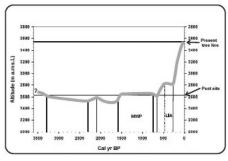

Figure 1: The tree line fluctuation based on the pollen-inferred vegetation and climate history of the Pinder valley. The medieval Warm Period (MWP) corresponds to ca. 1600 – 740 cal yr BP (~400 – 1260 cal AD), while the Little Ice Age (LIA) is represented by 460 – 270 cal yr BP (~1540 – 1730 cal AD) event.